

What is Claimed is:

A composition comprising at least one powdered material admixed with at least one thermally decomposable polyhydroxyalkanoate having a molecular weight of from about 500 to less than 70,000.

5 2. The composition of claim 1, wherein the molecular weight is from about 500 to 20,000.

3. The composition of claim 1, wherein the molecular weight is from about 500 to about 10,000

4. The composition of claim 1, wherein the molecular weight is from about 10 1,000 to about 5,000.

5. The composition of claim 1, wherein the molecular weight is from about 1,000 to about 3,000.

6. The composition of claim 1, wherein the polyhydroxyalkanoate is a polymer of one or more subunits having the chemical formula:

15 -OCR¹R²(CR³R⁴)_nCO-
wherein n is 0 or an integer, and wherein R¹, R², R³, or R⁴, which is the same or different, is selected from a saturated or unsaturated hydrocarbon radical; a halo- or hydroxyl-substituted radical; a hydroxy radical; a halogen radical; a nitrogen-substituted radical; an oxygen-substituted radical; or a hydrogen atom.

20 7. The composition of claim 1, wherein the polyhydroxyalkanoate is selected from poly(3-hydroxybutyrate), poly 3-hydroxybutyrate-co-3-hydroxyvalerate, poly 3-hydroxybutyrate-co-4-hydroxybutyrate, poly 3-hydroxybutyrate-co-3-hydroxyhexanoate, poly 3-hydroxybutyrate-co-3-hydroxyheptanoate, or poly 3-hydroxybutyrate-co-3-hydroxyoctanoate.

25 8. The composition of claim 1, wherein the polyhydroxyalkanoate is produced by a microbial fermentation process.

9. The composition of claim 1, wherein the polyhydroxyalkanoate is produced by a genetically engineered plant crop system.

10. The composition of claim 1, wherein the polyhydroxyalkanoate is produced 30 by a chemical polymerization reaction.

11. The composition of claim 10, wherein the chemical polymerization reaction is a ring opening polymerization reaction.
12. The composition of claim 1, wherein the polyhydroxyalkanoate comprises a polymer selected from the group consisting of poly(lactic acid)s, poly(glycolic acid)s, 3-hydroxyacids, 4-hydroxyacids, 5-hydroxyacids, copolymers thereof, and blends thereof.
13. The composition of claim 1, wherein the powdered material is selected from glass, ceramics, metals, alloys, or mixtures thereof.
14. The composition of claim 13, wherein the powdered material is present in an amount of from about 50 % to about 99.999 % by weight based on total dry weight of the composition.
15. The composition of claim 13, wherein the powdered material is a ceramic present in an amount of from about 70 % to about 99.999 % by weight based on total dry weight of the composition.
16. The composition of claim 1, wherein the polyhydroxyalkanoate comprises a mixture of thermally degradable polyhydroxyalkanoates.
17. The composition of claim 1, further comprising at least one thermally degradable polymer other than polyhydroxyalkanoate.
18. The composition of claim 17, wherein the thermally degradable polymer is selected from polycarbonates, polyolefins, polystyrenes, polyacetals, waxes, or combinations thereof.
19. The composition of claim 1, wherein the polyhydroxyalkanoate is dispersed in water.
20. The composition of claim 1, wherein the polyhydroxyalkanoate is dissolved in a solvent or a mixture of solvents.
21. A method of forming a shaped product, the method comprising: molding a composition comprising a powdered material admixed with at least one thermally decomposable polyhydroxyalkanoate of claim 1 or a solution thereof to form the shaped product.

22. The method of claim 21, wherein the powdered material is selected from glass, ceramics, metals, alloys, or mixtures thereof.

23. The method of claim 21, wherein the method of forming shaped products is selected from slip casting, tape casting, extrusion, injection molding, dry pressing, or 5 screen printing.

24. The method of claim 21, further comprising heating the shaped product to remove essentially all of the polyhydroxyalkanoate from the product.

25. A molded article formed by a method comprising:
molding a composition comprising a powdered material admixed with at 10 least one thermally decomposable polyhydroxyalkanoate of claim 1 or a solution thereof.

26. A molding composition comprising 70 wt% to 99.9 wt% of an inorganic material and 0.1-30 wt% of at least one polyhydroxyalkanoate having a molecular weight from 500 to less than 70,000 and the chemical formula:

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where n is 0 or an integer, and wherein R¹, R², R³, and R⁴, which are the same or different, are selected from saturated or unsaturated hydrocarbon radicals; halo, hydroxy, oxygen or nitrogen substituted radicals, or hydrogen atoms.

20 27. The molding composition of claim 26, wherein the inorganic material comprises iron, chromium, copper, nickel, aluminium, titanium, silicon oxide, silicon carbide, silicon nitride, or aluminum nitride.

28. The molding composition of claim 26, wherein the polyhydroxyalkanoate is polyhydroxybutyrate.

25 29. The molding composition of claim 26, wherein the polyhydroxyalkanoate is a copolymer of 60-99 wt% 3-hydroxybutyric acid and 1-40 wt% 3-hydroxyvaleric acid.

30. The molding composition of claim 26, wherein the polyhydroxyalkanoate is a copolymer of 60-99 wt% 3-hydroxybutyric acid and 1-40 wt% 4-hydroxybutyric acid

31. The molding composition of claim 26, wherein the polyhydroxyalkanoate is 30 poly 3-hydroxyoctanoate.

32. The molding composition of claim 26, wherein the polyhydroxyalkanoate is a copolymer containing at least 10 wt% by molar mass hydroxyoctanoate groups randomly distributed through the polymer chain.
33. The molding composition of claim 26, wherein the polyhydroxyalkanoate has a molecular weight of from about 1,000 to about 9,000.
- 5 34. The molding composition of claim 26, wherein the polyhydroxyalkanoate has a molecular weight of from about 1,000 to less than about 70,000
- 10 35. The molding composition of claim 26, wherein the polyhydroxyalkanoate has an end chain functionality selected from vinyl, carboxylic acid, carboxylic acid ester, acetate, butyrate, propanoate, primary, secondary or tertiary alcohol, amide, or polyhydric alcohol.
- 15 36. The molding composition of claim 26, wherein the polyhydroxyalkanoate is obtained by the thermolysis of a polyhydroxyalkanoate having a molecular weight greater than 80,000.
- 20 37. The molding composition of claim 26, wherein the polyhydroxyalkanoate has the structure $R^5CH=CH_2(CH_2)_{n-1}CO[OCHR^6(CH_2)_nCO]_pOH$, where p is from 5 to 1000, n is 0 or an integer, and R^5 and R^6 , which are the same or different, is selected from saturated or unsaturated hydrocarbon radicals; halo, hydroxy, oxygen or nitrogen substituted radicals, or hydrogen atoms.
- 25 38. The molding composition of claim 26, wherein the polyhydroxyalkanoate is obtained by the acid hydrolysis of a polyhydroxyalkanoate having a molecular weight of greater than 80,000.
39. The molding composition of claim 26, wherein the polyhydroxyalkanoate is obtained by the acid hydrolysis of a polyhydroxyalkanoate having a molecular weight of greater than 80,000 in the presence of an alcohol, diol or polyhydric alcohol.
- 25 40. The molding composition of claim 26, wherein the polyhydroxyalkanoate has the structure $H[OCHR^7(CH_2)_nCO]_pOR'$, wherein R' is derived from a monohydric alcohol or a polyhydric alcohol and wherein p is from 5 to 1000, n is 0 or an integer, and R^7 is selected from saturated or unsaturated hydrocarbon radicals; halo, hydroxy, oxygen or nitrogen substituted radicals, or hydrogen atoms.
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41. The molding composition of claim 26, wherein the polyhydroxyalkanoate is obtained by the acid hydrolysis of a polyhydroxyalkanoate having a molecular weight of greater than 80,000 in the presence of an aliphatic carboxylic acid.

42. A molding composition of claim 26, wherein the polyhydroxyalkanoate has 5 the structure $R''CO[OCHR^8(CH_2)_nCO]_pOH$, wherein R'' is derived from a carboxylic acid having 1 to 20 carbon atoms and wherein p is from 5 to 1000, n is 0 or an integer, and R^8 is selected from saturated or unsaturated hydrocarbon radicals; halo, hydroxy, oxygen or nitrogen substituted radicals, or hydrogen atoms.

43. The molding composition of claim 26, wherein the polyhydroxyalkanoate is 10 a block polymer containing at least 20 wt% of a polyhydroxyalkanoate segment and at least one polyalkylene glycol segment where the polyalkylene glycol is selected from one or more repeat units of ethylene oxide, propylene oxide or butylene oxide or mixtures of ethylene oxide, propylene oxide and/or butylene oxide.

44. A thermally decomposable polyhydroxyalkanoate having at least one of the 15 terminal end groups selected from:

- a) $-CO-CH=CR^9R^{10}$;
- b) $-OR^{11}$;
- c) $-COOR^{12}$,
- d) $-COR^{13}$; or
- e) $-OM^+$

20 wherein R^9 , R^{10} , R^{11} , R^{12} , or R^{13} which are the same or different, represents saturated or unsaturated hydrocarbon radicals, halo- or hydroxy- substituted radicals, hydroxy radicals, nitrogen-substituted radicals, oxygen-substituted radicals, or a hydrogen atom, with the proviso that R^{11} is not a hydrogen atom, and M^+ is a counter ion.

25 45. The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said second terminal end group is $-CO-CH=CR^9R^{10}$.

46. The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said second terminal end group is $-OR^{11}$.

30 47. The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said second terminal end group is $-COOR^{12}$.

48. The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said polyhydroxyalkanoate has a molecular weight of from about 500 to less than 70,000

49. The thermally decomposable polyhydroxyalkanoate of claim 44, wherein said polyhydroxyalkanoate has a molecular weight of from about 10,000 to about 1.5
5 million.

50. A composition comprising at least one powdered material admixed with the thermally decomposable polyhydroxyalkanoate of claim 44.

51. A method of making the thermally decomposable polyhydroxyalkanoate of claim 44, comprising subjecting a thermally decomposable polyhydroxyalkanoate having a
10 molecular weight of greater than 70,000 to an acid hydrolysis.

52. A method of making the thermally decomposable polyhydroxyalkanoate of claim 44, comprising subjecting a thermally decomposable polyhydroxyalkanoate having a molecular weight of greater than 70,000 to a heat profile to decompose the polyhydroxyalkanoate

15 53. The method of claim 52, wherein said thermolysis occurs at a temperature of from about 195°C to about 250°C at atmospheric pressure.

54. The method of claim 53, wherein said thermolysis occurs for a period of from about 15 seconds to about 4 hours.

55. The method of claim 51, wherein said thermally decomposable
20 polyhydroxyalkanoate is a dried biomass containing inorganic salts.

56. The method of claim 51, wherein said thermally decomposable polyhydroxyalkanoate is a dried biomass washed free of water soluble salts.

57. The method of claim 51, wherein said thermally decomposable polyhydroxyalkanoate is a purified polymer.

25 58. The method of claim 51, wherein the yield is greater than 80 % by weight based on the polyhydroxyalkanoate content.

59. The method of claim 52, wherein said method occurs in an inert gas.

60. The method of claim 52, wherein said method occurs in a reducing atmosphere.

61. The method of claim 52, wherein said thermally decomposable polyhydroxyalkanoate is a dried biomass containing inorganic salts.

62. The method of claim 52, wherein said thermally decomposable polyhydroxyalkanoate is a dried biomass washed free of water soluble salts.

5 63. The method of claim 52, wherein said thermally decomposable polyhydroxyalkanoate is a purified polymer.

64. A method of claim 51, wherein said acid hydrolysis occurs in the presence of an alcohol, a diol, a polyhydric alcohol, or combinations thereof.

10 65. The method of claim 51, wherein said hydrolysis occurs in an excess amount of alcohol, diol, thiol, or combinations thereof.

66. The method of claim 65, wherein at least 1 % by weight residual alcohol, diol, or polyol remains in the reaction product.

67. The method of claim 59, wherein said inert gas is a nitrogen gas optionally in the presence of an alcohol vapor.

15 68. The composition of claim 1, wherein said powdered material is a metal powder comprising iron, steel, copper, nickel, tungsten, or combinations thereof and said polyhydroxybutyrate comprises poly 3 hydroxybutyrate or a copolymer of 3 hydroxy butyrate with 3 hydroxyvalerate or 4 hydroxybutyrate.

20 69. The composition of claim 1, wherein said powdered material is a ceramic powder comprising barium titanate, aluminium hydroxide, alumina, wollastonite, silica, or combinations thereof and said polyhydroxybutyrate comprises poly 3 hydroxybutyrate or a copolymer of 3 hydroxy butyrate with 3 hydroxyvalerate or 4 hydroxybutyrate.

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